

LICHENS FROM THE T. G. B. OSBORN VEGETATION RESERVE AT KOONAMORE IN ARID SOUTH AUSTRALIA

by R. W. ROGERS*

Summary

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The Koonamore Vegetation Reserve has a lichen flora of at least 38 species. The level of endemism (19% confined to Australian arid regions) is lower than that in other arid lands, but the total number of species is similar to that found in the arid lands of Asia and North Africa, and the percentage of foliose species is higher. It is possible that either the environment at Koonamore is less harsh than other areas with similar rainfall, or that Australian foliose species are more drought resistant than those from other areas. However, the broad species concept followed here, and the topography of the reserve also, tend to limit the number of crustose species. All soil-surface species occur more frequently on loamy soils than on sandy soils. It is suggested that *Collema coccophorus*, *Dermatocarpon lachneum*, *Endocarpon pusillum* and *Heppia lutosa*, the species most common on sand and most commonly occurring alone, are the pioneer species on the soil. Brief descriptions and a key to the species of lichens found on the reserve are appended.

Introduction

There have been a number of recent studies concerning lichens in arid southern Australia (Rogers 1971, 1972a, 1972b; Rogers & Lange 1971, 1972); however, these have dealt only with species growing on the soil.

The T. G. B. Osborn Vegetation Reserve at Koonamore (139°27'E, 32°15'S) was established in 1925 to study the regeneration of over-grazed arid shrubland, this work being summarised by Hall, Specht & Eardley (1964). Although it is only small (390 hectares), it has a vegetation representative of much of arid South Australia. The Reserve is located in an area where vegetation formations of the more arid, low, open shrublands to the north occur admixed with formations from the low woodlands to the south. The Reserve has a rainfall of only 182 mm per annum, and, using the criteria of Meigs (1953) is Arid.

The only report concerning lichens from the Reserve is in Osborn, Wood & Paltridge (1935). The collections were made by C. Barnard, and specimens sent to Kew for determination. Examination of the material retained as duplicates in the herbarium of the University of

Adelaide (ADU) shows that some of the confusion in the discussion of lichens by Osborn, Wood & Paltridge was due to limited knowledge of lichens and their structure.

The "undetermined species of *Acarospora*" referred to as forming patches up to 8 cm in diameter is, in the specimens retained, mostly large colonies of *Diploschistes scruposus*. However, in a few cases, small, fertile thalli of *A. smaragdula* (rarely 2 cm in diameter) are present in the crust of *D. scruposus*. It is probable that similar material was sent to Kew, and the obviously fertile *Acarospora*, but not the often sterile *Diploschistes*, determined. Two of the three other soil-surface species discussed as being conspicuous because of their apothecia, are not so. *Lecidea decipiens* has small pink squamules with a white edge, and rarely, black marginal apothecia. Osborn, Wood & Paltridge apparently mistook the small thallus for an apothecium. Similarly, they confused the thallus of *Dermatocarpon hepaticum* with apothecia: *D. hepaticum* has immersed perithecia, not apothecia.

During 1965-1971 the Reserve was visited frequently by the author who collected specimens for lichen studies.

*Botany Department, University of Queensland, St. Lucia, Qld. 4067.

The Lichen Flora

The soil lichens at Koonamore are a striking feature of the Reserve. Over much of the area the lichens form a continuous carpet, which is rich in species. Many of the small calcareous pebbles on the soil surface are completely encrusted with lichens, often with a variety of species on a pebble no more than 1 cm in diameter. Bark and wood of live or dead trees and shrubs supports a usually sparse growth of lichens.

From the collections made in 1965-1971, and from collections housed in the Botany Department, University of Adelaide, 38 species in 25 genera were determined by reference to the literature and herbarium material. These are listed in the Appendix. The flora is comparable in number of species to that found in south-western Africa (41 species; Doidge 1950), in Arizona (33 species; Fink 1909) and in the Negev (37 species; Galun & Reichert 1960).

Brief descriptions and a key to the species from the Reserve appear in the Appendix.

Biogeographic Considerations

Weber (1962) commented on the similarity of arid zone lichen floras from various continents. Rogers & Lange (1972) illustrated this by reference to the soil-surface lichens from all continents except South America.

In desert areas, the genera *Acarospora*, *Aspicilia*, *Buellia*, *Caloplaca*, *Collema*, *Dermatocarpon*, *Endocarpon*, *Heppia*, *Lecanora*, *Rhodiina* and *Verrucaria* dominate the lichen floras. All these genera are crustose. The most common foliose genus is apparently *Physcia*, but *Parmelia*, *Teloschistes* and *Xanthoria* are also

widespread. All of these genera are recorded in the Reserve although it is likely that the records for *Rhodiina* and *Buellia* are based on identical material (see comment in species descriptions).

Literature was searched to see whether the species occurring at Koonamore grow in other deserts. Reports were placed into four regional groupings: North America (Fink 1909, Herre 1911, Rudolph 1953, Weber 1963), North Africa (Faurel, Ozenda & Schotter 1953), western Asia (Steiner 1921, Lamb 1936, Szatala 1957, Galun & Reichert 1960, Poelt & Wirth 1968), and southern Africa (Doidge 1950).

Of the 38 species found in the Reserve, four occur in each of the other four desert regions considered. These are *Acarospora schleicheri*, *Caloplaca murorum*, *Dermatocarpon lachneum* and *Lecidea decipiens*. A further four species, *Endocarpon pustillum*, *Parmelia pulla*, *Physcia stellaris* and *Toninia caeruleontgricans* occur in three of the four regions.

The seven taxa (19%) asterisked in Appendix II are endemic to Australia, with the exception of *Chondropsis semiviridis* and *Parmelia reptans*, which also occur in New Zealand. This is lower than the 30% endemism recorded by Faurel, Ozenda & Schotter (1953) for the Sahara, and similar to the endemism reported by Galun & Reichert (1960) for lichens from the Negev, Israel. Of the other species, 18 (48%) are also found in North American deserts, 14 (37%) in southern Africa, 11 (28%) in western Asian deserts, and 8 (21%) in the Sahara.

Comparison with floras from other arid lands (Table 1) indicates that the flora at Koonamore is unusually rich in foliose species. The most

TABLE 1

Life-form spectra for the lichen population in desert regions, with other South Australian spectra for comparison.

Location	% crustose and squamulose species	% foliose species	% fruticose species
Koonamore	58	42	0
Reno (Herre 1911)	75	25	0
Tucson (Fink 1909)	91	9	0
Negev (Galun and Reichert 1960)	91	6	3
Sahara (Faurel, Ozenda and Schotter 1953)	97	3	0
Arid South Australia*	75	23	2
Semi-Arid South Australia*	57	35	8
Temperate South Australia*	37	41	22
All of South Australia*	45	36	19

*Rogers, R. W. (1971) Unpublished Ph.D. thesis (University of Adelaide) Appendix I, pp. 183-186.

directly comparable area is that studied by Fink (1909) at Tucson. That area was somewhat larger with more diverse substrates and a slightly higher rainfall. The area studied by Herre (1911) at Reno included an altitudinal range of several thousand feet, also with a higher rainfall than Koonamore. Both of these areas were, however, poorer in foliose species. From Table 1 it is also evident that the Koonamore Reserve is relatively richer in foliose species than arid South Australia taken as a whole.

Renau, Marrache & Trotet (1968) examined the use of lichen life-form spectra as indicators of aridity. With 42% foliose species, Koonamore would rate as sub-humid or perhaps semi-arid on their scale whereas it is classed as arid by use of climatic indices (Meigs 1953). At first this suggests that either the climate at Koonamore is less harsh in relation to its rainfall and temperature regime than other desert regions, or that southern Australian foliose lichens are more drought resistant than their counterparts elsewhere. However, the relatively high percentage of foliose lichens on the Koonamore Reserve may be due in part to the absence of outcropping rocks in the area. Two species absent from the Reserve, but which occur on rocky outcrops in the nearby Yunta and Waukaranga hills, are *Diploschistes sypsaeanus* (crustose) and *Heppia euploea* (squamulose). Another factor may be the broad species concept followed in naming the Koonamore lichens. While many taxonomists will not accept the revision of *Acarospora* subgenus *Xanthothallia* by Weber (1968), in which about 80 accepted species were reduced to two, his conclusion that the number of crustose lichens from arid areas is greatly inflated by description of environmental modifications as distinct taxa (Weber 1962) is sound. Apart from the genus *Acarospora*, the genera *Lecanora* and *Leclidea* have also been split to accommodate numerous environmental modifications. It is likely that other authors have followed rather narrow species concepts, increasing the total number and hence proportion of crustose species recorded from arid lands. This may also explain the similarity with the North American desert lichen flora, since both the present author and North American authors have followed a similar broad species concept.

Ecology of Soil Surface Species

To study the soil-surface lichens, 26 transects were randomly located in the physiographically diverse south-eastern half of the reserve. Along

each transect, ten 15 cm by 20 cm quadrats were laid at random intervals between zero and ten metres apart, and the soil surface lichens within the quadrats listed. The soil type was classified into one of two categories, calcareous loam or sand.

Thirteen taxa occurred in more than ten of these quadrats; these are listed in Table 2, along with their frequency in loamy and sandy quadrats. Of the 260 quadrats, 67 were without lichens. Fifty-five of the quadrats without lichens were on sandy areas, 12 on loamy areas. Of the loamy quadrats 85% had lichens, whereas only 52% of the sandy quadrats did. The site with the greatest number of species (nine) was on loamy soil, whereas the richest site on sandy soil had seven species. The mean number of species on sandy sites bearing lichens was 3.5, significantly lower ($p < 1\%$) than the mean of 4.3 on loamy sites with lichens.

If it is assumed that there is an increase in species diversity as a community develops towards its climax composition (Whittaker 1953), then it follows that species which tend to occur alone are more likely to be pioneer species than those which tend to occur only with others. From Table 2, it is apparent that *Collema coccophorus*, *Endocarpon pusillum*, *Dermatocarpon lachneum* and *Heppia lutosu* are the species most commonly occurring alone, or with few others. These species are therefore likely to be the pioneer species, occurring early in successional development on soil surfaces.

A number of sites on the reserve were discovered where lichen crusts were judged to be advancing on to previously uncrusted areas. This judgment was based on the presence of scattered squamules at a distance from a developed crust, the squamules becoming smaller and apparently younger as distance from the crust increased. *Dermatocarpon lachneum*, *Endocarpon pusillum* and *Heppia lutosu* were the species commonly found in such situations.

These observations, together with the observations of Rogers & Lange (1971) that *Collema coccophorus*, *Dermatocarpon lachneum*, *Endocarpon pusillum* and *Heppia lutosu* are the species least affected by trampling of sheep around waterholes, all point to the same group of species as the pioneers in lichen succession on arid soils in South Australia.

The distribution of lichen crusts in relation to shrub coverage was studied on Quadrat 100, an area of 100 m² of fine, calcareous soil on which regeneration of *Atriplex* spp. has been

TABLE 2

Frequency of soil-surface species on loamy soils and sandy soils from the Koonamore Vegetation Reserve, and the frequency with which these were either the only species in a quadrat, or were with only one other species.

Species	Frequency on loam	Frequency on sand	Number of occurrences	
			alone	with one other
<i>Acuropora smaragdula</i>	9	0	0	0
<i>Aspicilia calcarea</i> (crustose)	54	22	1	2
<i>A. calcarea</i> (fruticose)	18	1	0	1
<i>Chondropsis semiviridis</i>	1	0	0	0
<i>Collema coccophorus</i>	55	49	14	16
<i>Dermatocarpon lachneum</i>	63	11	2	4
<i>Endocarpon pusillum</i>	43	35	3	15
<i>Fulgensia subbracteata</i>	24	12	0	1
<i>Heppia polyspora</i>	35	3	0	1
<i>H. ludosa</i>	30	18	1	6
<i>Lecidea crystallifera</i>	20	3	0	2
<i>L. decipiens</i>	66	19	0	2
<i>Tominia coeruleonigricans</i>	13	12	1	0

studied since 1925. On this quadrat it was possible in 1969 to find areas on which no perennial plant growth had been recorded in the past 44 years. These areas were without lichen growth. On areas with mature perennial shrub growth, a lichen crust had developed; the older the shrub stand, the more developed the lichen crust. A few areas were found in which the shrubs had virtually all died: in these the lichen crust remained intact. In yet other areas, young shrubs were starting to grow on areas quite devoid of lichen growth.

It is apparent from these observations that the lichen crust develops on fine calcareous soils only after a shrub cover has been established, thus stabilising the soil. However, it is also apparent that the lichens are able to prevent erosion of the soil once the shrub cover

has disappeared. Lichen crusts thus increase the stability of desert soils: they cannot themselves stabilise an actively eroding surface.

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Appendix

1. KEY TO SPECIES

- 1. Thallus fruticose—i.e. without dorsiventral differentiation 4
 - 1. Thallus foliose, squamulose or crustose—i.e. with dorsiventral differentiation 2
 - 2. Thallus foliose or squamulose either free from the substrate, or attached to it by rhizoids, but with a distinct lower surface 3
 - 2. Thallus crustose, attached to the substrate and inseparable from it, no lower surface discernible, or thallus absent 29
 - 3. Thallus foliose, i.e. of elongate, often branched lobes 7
 - 3. Thallus squamulose, i.e. of round to ovoid scales which may be crowded together 21
- FRUTICOSE SPECIES
- 4. Thallus gold to grey, on wood or bark
Teloschistes chrysophthalmus
 - 4. Thallus grey, black or dark olive green, on rock or soil 5
 - 5. Thallus grey, of anastomosing cylindrical lobes
Aspicilia calcarea
 - 5. Thallus black or dark olive green, the lobes not anastomosing 6
 - 6. Thallus of cylindrical lobules or flattened lobes up to 5 mm high, forming a rosette
Collema coccophorus
 - 6. Thallus of cylindrical lobes up to 2 mm high, the individuals densely packed to form an apparent crust
Synalissa symphorea
- FOLIOSE SPECIES
- 7. Thallus black or dark olive green, gelatinous when wet
Collema coccophorus
 - 7. Thallus not black nor gelatinous when wet . . . 8
 - 8. Thallus bright yellow, gold or orange 9
 - 8. Thallus olive, grey, blue or yellow-green 11
 - 9. Thallus of minute, flattened, eciliate lobes (less than 1 mm broad), upper cortex K—
Candelaria concolor
 - 9. Thallus of broader lobes, sometimes ciliate, upper cortex K+ burgundy 10

- 10. Lobes eciliate, appressed to the substrate
Xanthoria ectanea
- 10. Lobes ciliate, ascending from the substrate
Teloschistes chrysophthalmus
- 11. Upper surface yellow green 12
- 11. Upper surface grey, blue or olive 16
- 12. Thallus rolling into a ball when dry, unrolling when wet
Chondropsis semiviridis
- 12. Thallus not rolling and unrolling 13
- 13. On soil surfaces 14
- 13. On rocks, wood or bark 15
- 14. Thallus free on the surface, much distorted and convoluted
Parmelia convoluta
- 14. Thallus attached to the surface by rhizoids, lobes slightly convex, appressed
Parmelia reptans
- 15. On wood or bark
Parmelia ferax
- 15. On rocks
Parmelia cf. lineola
- 16. Thallus olive 17
- 16. Thallus blue or grey 18
- 17. Lobes 1 mm broad or less
Physciopsis syncolla
- 17. Lobes more than 1 mm broad
Parmelia pulla
- 18. Lobes more than 3 mm broad
Parmelia subalbicans
- 18. Lobes less than 2 mm broad 19
- 19. Lobes with marginal soralia
Physcia albicans
- 19. Lobes esorediate 20
- 20. Medulla K+ yellow
Physcia alba
- 20. Medulla K—
Physcia stellaris

SQUAMULOSE SPECIES

- 21. Phycobiont blue-green 22
- 21. Phycobiont green 23
- 22. Squamules elongate, margins granular but not thickened, forming a rosette
Heppia lutea
- 22. Squamules ovoid or crenate, margins smooth, thickened, not forming a rosette
Heppia polyspora

- 23. Squamules orange to red, often with a white margin ... *Leclidea decipiens*
- 23. Squamules brown, black, grey-green or grey ... 24
- 24. Squamules thin, pale grey-green, the margins curling up when dry ... *Cladonia squamules*
- 24. Squamules thicker, brown, black or grey, the margins not curling up when dry ... 25
- 25. Asci in perithecia immersed in the thallus ... 26
- 25. Asci in apothecia sessile on the thallus ... 28
- 26. Spores muriform, algae in the hymenium ... *Endocarpon pusillum*
- 26. Spores not septate, algae absent from the hymenium ... 27
- 27. On soil, squamules brown 2-3 mm across ... *Dermatocarpon lachneum*
- 27. On rock, squamules black less than 1 mm across ... *Dermatocarpon compactum*
- 28. Squamules pale grey or brown, epruinose, the upper surface deeply cracked, giving a crystalline appearance, apothecia small in relation to the squamules ... *Leclidea crystallifera*
- 28. Squamules dark grey or black, often pruinose, the upper surface shallowly cracked, apothecia large in relation to the squamules ... *Tanlaia coeruleonigricans*

CRUSTOSE SPECIES

- 29. Thallus or apothecia yellow or orange ... 30
- 29. Thallus and apothecia devoid of orange or yellow coloration ... 34
- 30. Thallus with small but distinct marginal lobes ... 31
- 30. Thallus without distinct marginal lobes or thallus absent ... 32
- 31. Thallus smooth, orange to orange brown ... *Caloplaca murorum*
- 31. Thallus mealy, very pale yellow when dry becoming bright yellow when wet ... *Fulgensia subbracteata*

- 32. On rocks or soil, spores more than 64 per ascus ... *Acarospora schleicheri*
- 32. On wood, spores 8 per ascus ... 33
- 33. Apothecia bright yellow, thallus absent or only a prothallus present ... *Condelarrella antennaria*
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- 34. Crust black, of minute squamules or minute fruticose individuals closely packed ... 35
- 34. Crust white to brown, sometimes areolate or granular, but not squamulose or fruticose individuals ... 36
- 35. Thallus gelatinous when wet, individuals minutely fruticose about 0.1 mm diameter; asci in apothecia ... *Synalissa symphorea*
- 35. Thallus not gelatinous when wet, individuals squamulose, asci in perithecia ... *Dermatocarpon compactum*
- 36. Spores 64 or more per ascus ... 37
- 36. Spores less than 16 per ascus ... 38
- 37. Thallus brown, without marginal lobes, usually one apothecium per areole, on rock ... *Acarospora cervina*
- 37. Thallus grey, with distinct marginal lobes, apothecia usually several per areole, on soil and rock ... *Acarospora smaragdula*
- 38. Asci in perithecia, thallus virtually indistinguishable from the substrate ... *Verrucaria* cf. *calceolata*
- 38. Asci in apothecia, thallus quite distinct ... 39
- 39. Apothecia immersed or adnate on the thallus ... 40
- 39. Apothecia sessile on the thallus ... 42
- 40. Apothecia 3 mm or more in diameter ... *Diploschistes ocellatus*
- 40. Apothecia less than 2 mm diameter ... 41
- 41. Spores black or brown ... *Diploschistes seruposus*
- 41. Spores hyaline ... *Aspicilla calcarea*
- 42. Spores black or brown ... *Buellia subalbula*
- 42. Spores hyaline ... *Lecanora sphaerospora*

II. DESCRIPTIONS OF THE SPECIES

Acarospora cervina (Ach.) Mass. 1852:28.
Lecanora cervina Ach. 1814:188.
 Thallus of small (1-2 mm broad) brown squamules with white margins, usually scattered but occasionally compacted. Apothecia immersed, pruinose, usually one per squamule. Spores many (>100) per ascus, non-septate.
 Occasional on small calcareous pebbles. Specimen examined*: Rogers, 24.iii.1969.

Acarospora schleicheri (Ach.) Mass. 1852:27.
Urceolaria schleicheri Ach. 1810:332.
 Thallus of minute (<1 mm diam.) sulphur yellow squamules, usually scattered, but sometimes becoming areolate. Apothecia immersed, one per squamule. Spores many (>100) per ascus, non-septate.

Rare, found only on silicious pebbles at Koonamore, but may also occur on compacted soil. Specimen examined: Womersley, 6.vi.1946.

Acarospora smaragdula (Wahlenb.) Mass. 1852:29.
Endocarpon smaragdulum Wahlenb. apud Ach. 1803:29.
 Thallus of small (1-2 mm in diam.), chalky white to brown squamules, forming plaques up to 2 cm in diam. Apothecia immersed, sometimes pruinose, one to five per squamule, a well developed exciple concolorous with the thallus. Spores many (>100) per ascus, non-septate.

Common on calcareous soil surfaces, often with *Diploschistes seruposus*. Specimens examined: Barnard, 12.xii.1927; Anon., May 1943; Eardley, June 1946; Rogers, 20.xi.1967.

* Specimens cited as Rogers are in the author's private herbarium, all others in the herbarium of the University of Adelaide (ADU).

Aspicilia calcarea (L.) Mudd 1861:161.

Lichen calcareus L. 1753:1140.

Thallus white to greyish, either crustose or more or less fruticose; if crustose then areolate, if fruticose the lobes cylindrical, pseudocypbellate, anastomosing, 0.5-1.0 mm thick. Apothecia known only on crustose forms, immersed with a crenate margin, the disc densely pruinose. Spores 2-8 per ascus, non-septate.

Virtually any calcareous pebble on the reserve has the crustose form on it somewhere. The fruticose form is less common but occurs most often at the junction of pebbles and soil. Both forms also occur on calcareous soil alone. Numerous intergrades have been observed on the reserve. Specimens examined: Anon., May 1948; Rogers, 8.xii.1967.

Bombyliospora domingensis (Pers.) Zahlbr. var. *aurantiaca* Zahlbr., in Magnusson & Zahlbruckner 1945:32.

Thallus an obscure yellow-grey crust covering extensive areas on old wood. Apothecia orange, <1 mm in diam., very numerous, sessile, convex. Spores 8 per ascus, usually 5 septate.

Very common on dead, decorticate twigs, especially of *Cassia* spp. and *Eremophila* spp., where entire branches may be covered. Specimens examined: Barnard, 12.xii.1927; Rogers, 5.xi.1967.

Buellia subalbula (Nyl.) Muell, 1880:79.

Lecidea subalbula Nyl. 1868:516.

Thallus a white, areolate crust forming patches up to 5 cm in diam. Apothecia black, up to 1 mm in diam., numerous, sessile, convex, with a false white exciple disappearing early in development. Spores 8 per ascus, black, septate.

Very common on calcareous pebbles. Specimens examined: Anon., June 1946; Anon., May 1948; Rogers, 24.iii.1969.

Although the material has not been examined it is likely that specimens determined at Kew as *Rhodina diffractella* Muell. for Osborn, Wood & Paltridge (1935), was identical with the material here called *B. subalbula*. The two species are very similar according to their descriptions, each having a thalloid exciple when young, which disappears with age, hence confusion about the appropriate genus for the material. The species differ, however, in that there are slightly larger spores (12-12.6 x 5.7-6 µm) in *B. subalbula* than in *R. diffractella* (7-10 x 4-4.5 µm).

Colophaea murorum (Hoffm.) Th. Fr. 1871:170.

Lichen murorum Hoffm. 1784:63.

Thallus crustose, areolate at the centre, sometimes with distinct marginal lobes 1-2 mm long, or the thallus of verrucose squamules, light orange-brown. Apothecia sessile, the disc orange to rusty brown, the exciple concolorous with the thallus. Spores 8 per ascus, polar-bilocular.

On siliceous rocks, not common. Specimens examined: Womersley, 6.vi.1946; Anon., May 1948.

Candelaria concolor (Dicks.) Stein in Cobbi 1879:84.

Lichen concolor Dicks. 1793:18.

Thallus yellow, minutely foliose, lobes 0.1-0.5 mm broad, c. 1 mm long, forming rosettes or

spreading irregularly, the margins irregularly granular. Fertile specimens have not been found in South Australia. According to Osborn, Wood & Paltridge (1935) this species is uncommon, but forms extensive patches on twigs. This species has not been relocated by recent collectors despite careful examination of the area.

Record: Barnard, 12.xii.1927 (not seen).

Candelariella antennaria Ras. 1939:137

Thallus missing. Apothecia sessile on the substrate, the disc and exciple greenish yellow. Spores 8 per ascus, non-septate. Paraphyses septate, sometimes branched.

A common but obscure species occurring admixed with *Bombyliospora domingense* var. *aurantiaca* on wood. Specimens examined: Rogers, 22.ix.1969; Rogers, 14.1.1971.

Chondropsis semiviridis (F. Muell. ex Nyl.) Nyl. ex Cromb. 1880:397.

Parmeliopsis semiviridis F. Muell. ex Nyl. 1885:57.

Thallus foliose, green above, pale yellow-brown below, lobes 3-5 mm broad, strictly dichotomously branched, rolling into a ball when dry, lying flat when wet. Apothecia extremely rare, sessile, disc brown, exciple concolorous with the thallus. Spores 8, non-septate.

At Koonamare this species has lobes approaching 5 mm wide, possibly the broadest form found in Australia. Common on soil surfaces in scattered patches. Barnard apparently did not find this distinctive species on the reserve in 1927. Specimens examined: Anon., May 1942; Barnard, ?1944; Rogers, 29.xi.1968.

Cladonia sp.

Scattered squamules grey green above, white below, without podetial development.

Very rare on shaded soil under *Heterodendrum*. Specimens examined: Rogers, 8.xii.1967.

Collema corcophorum Tuck. 1862:385.

Thallus a rosette of deep olive to black crenate lobes 2-3 mm long, much convoluted, sometimes with cylindrical lobules, gelatinous when wet. Apothecia not common, about 1 mm broad, the disc and exciple concolorous with the thallus. Spores 2 per ascus, once septate.

Infrequent, on calcareous or sandy soil. Specimens examined: Rogers, 8.xii.1967.

Delectoagarpon compactum (Mass.) Lettau. 1912:52.

Placidium compactum Mass. 1856:32.

Thallus of minute (0.2-0.3 mm) squamules packed together forming a dark brown plaque. Perithecia opening by pores, spores 8 per ascus, non-septate.

Common, but inconspicuous on calcareous pebbles. Specimens examined: Rogers, 9.ix.1969.

Dermatoagarpon lachneum (Ach.) Smith 1911:270.

Lichen lachneum Ach. 1798:140.

Thallus of tan to dark brown squamules 1-2 mm across, initially ovate, entire, plane to slightly convex but becoming crenate and distorted with age. The rhizoids of this species remain fine, permitting it to be distinguished from the coarse

rhizoid *Endocarpon pusillum*. Perithecia opening by pores. Spores 8 per ascus, non-septate.

Common and conspicuous on calcareous soil, superficially like *Endocarpon pusillum*. Specimens examined: *Barnard*, 12.xi.1927; *Rogers*, 20.xi.1967.

Diplochistes ocellatus (Vill.) Norm. 1853:232.

Lichen ocellatus Vill. 1789:988.

Thallus an extensive white crust of smooth, chalky areoles up to 1 mm broad. Apothecia poorly developed or absent on the reserve, but sessile with a thick thalloid exciple and a black, flat disc. Spores 8 per ascus, black, muriform.

A rare, but quite striking lichen on calcareous soil in deeply shaded sites. Specimens examined: *Anon.*, May 1942; *Eardley*, June 1946; *Rogers*, 2.v.1969.

Diplochistes scraposus (Schreb.) Norm. 1853:232.

Lichen scraposus Schreb. 1771:133.

Thallus an extensive floury grey or white crust with areoles < 1 mm across. Apothecia very common, immersed, c. 0.5 mm in diam., the disc black. Spores 8 per ascus, black, muriform.

Common on calcareous soils. Specimens examined: *Barnard*, 12.xii.1927; *Eardley*, June 1946; *Rogers*, 20.xi.1967.

Endocarpon pusillum Hedw. 1789:56.

Thallus of brown, usually crenate, squamules with extensive rhizoidal and stolon development below. Perithecia immersed, opening by a black pore on the upper surface. Spores usually 2 per ascus, black, muriform.

Common on calcareous soils and firm sands, easily confused with *Dermatocarpon lachneum*. Specimen examined: *Rogers*, 20.xi.1967.

Fulgensia subbracteata (Nyl.) Poell 1961, no. 137.

Lecanora subbracteata Nyl. 1885:534.

Thallus crustose, somewhat granular, very pale yellow when dry, bright yellow when wet, the margins showing minute lobes. Apothecia adnate, rare, the exciple colored like the disc, deep-rusty brown. Spores 8 per ascus, non-septate.

Rare, on sandy and calcareous soils. Specimen examined: *Rogers*, 2.v.1969.

Heppia lutosa (Ach.) Nyl. 1885:45.

Collema lutosum Ach. 1814:309.

Thallus squamulose grey-green to olive, squamules forming small rosettes (5 mm in diam.) the margins granular. Apothecia immersed, usually one per squamule, disc red. Spores 8 per ascus, non-septate.

Common on calcareous soils. Specimen examined: *Rogers*, 4.vii.1969.

Heppia polyspora Tuck. 1882:115.

Thallus squamulose, tan to olive, squamules 1-4 mm in diam., round or crenate with a thickened margin. Apothecia usually one per squamule, immersed, the disc red. Spores many (>32) per ascus, non-septate.

Common, but very obscure on sandy and calcareous soils. Specimen examined: *Rogers*, 4.vii.1969.

**Lecanora sphaerospora* Muell. 1892:196.

Thallus crustose, white to grey, areolate, areoles up to 1 mm in diam. Apothecia sessile with a white margin, usually crenate, the disc grey, at first flat then becoming markedly convex. Spores 8 per ascus, non-septate.

Very common on calcareous pebbles. Specimens examined: *Rogers*, 8.xii.1967; *Rogers*, 30.vi.1969.

**Lecidea crystallifera* Tayl. 1847:148.

Thallus of grey-brown squamules 1-3 mm broad, entire to crenate or somewhat lacerate, the upper surface sculptured into a mass of pyramid-like solid angles, giving it a crystalline appearance. Apothecia not found at Koonamore, but sessile, flat to convex, the disc dark grey to black. Spores 8 per ascus, non-septate.

Very common on calcareous soils. Specimen examined: *Rogers*, 20.xi.1967.

Lecidea decipiens (Hoffm.) Ach. 1803:80

Psora decipiens Hoffm. 1794:68.

Thallus of pink squamules 1-7 mm broad, the margins or the whole thallus white pruinose, the squamules entire to crenate or lacerate, often markedly concave at the centre with deflexed margins. Apothecia rare, marginal, sessile, the disc black, markedly convex. Spores 8 per ascus, non-septate.

One of the most common and obvious lichens on soil in the reserve. Specimens examined: *Barnard*, 12.xii.1927; *Anon.*, 1.ix.1932; *Eardley*, June 1946; *Rogers*, 20.xi.1967.

**Parmelia convoluta* Krmph. 1880:337.

Thallus yellow-green above, foliose; the lower surface light brown, sparsely rhizinate, usually concealed within the rolled and convoluted lobes, the older lobes often rugose above, up to 5 mm broad. Apothecia very rare, sessile, the disc brown, the margin yellow green.

This species is separated from the very similar *P. australiense* by the presence of salicylic acid (medulla K⁻ yellow becoming red) whereas *P. australiense* lacks salicylic acid and is therefore K⁻ (Kurokawa 1969). Mixed populations have been found in some places, but all Koonamore material examined is *P. convoluta*.

Common, lying free on the soil surface. Specimens examined: *Barnard*, 12.xii.1927; *Anon.*, May 1942; *Rogers* 20.xi.1967; *Rogers*, 17.v.1969.

**Parmelia ferax* Muell. 1886:257.

Thallus yellow-green above, foliose, the lower surface black, sparsely rhizinate, lobes 0.5-1.5 mm broad, margins crenate, branching irregular. Apothecia common, margin colored like the thallus, the disc brown. Spores 8 per ascus, non-septate.

Parmelia ferax may be confused with *P. rutidota*, but it has a more rugose thallus, has no K⁻ acids, and produces physodalic not protocetraric acid (Kurokawa 1967).

Common on dead twigs and bark of trees. Specimens examined: *Barnard*, 12.xii.1927; *Anon.*, May 1942; *Womersley*, 6.vi.1946; *Rogers*, 20.xi.1967.

Parmelia cf. *lineola* Beity. 1941:77.

Thallus yellow-green above, foliose, the lower surface pale to dark brown, closely adnate to the substrate, lobes 2-5 mm broad, sub-dichotomous,

the upper surface becoming rugose and cracking. Apothecia not seen.

The subgenus *Xanthoparmelia* to which this material belongs is complex and poorly understood. Absence of isidia and soredia, and presence of salicinic acid, place this species close to *P. lineola*, a western North American species.

Rare on quartzitic pebbles. Specimens examined: *Womersley*, 6.vi.1946; *Anon.*, May 1948; *Rogers*, 21.xi.1967.

Parmelia pulla (Schreb.) Ach. 1814:206

Lichen pullus Schreb. 1771:131.

Thallus dark olive or brown above, foliose, the lower surface dark, lobes 1.5–3.0 mm broad, sparsely rhizinate, the margins crenate, branching irregular. Apothecia rare, the margin concolorous with the thallus, disc dark brown. Spores 8 per ascus, non-septate.

Rare, on deeply shaded calcareous soils and rocks. Specimens examined: *Womersley*, 6.vi.1946; *Anon.*, May 1948.

**Parmelia reptans* Kuroki in Baker *et al.* 1973:137.

Thallus yellow-green above, foliose, forming rosettes 1–3 cm in diam., more or less dichotomously branched, lobes linear, 0.7–2.0 mm broad, lower surface pale brown with long black rhizoids. Apothecia unknown.

Very similar to *P. amphixantha* Muell., however *P. reptans* tends to have wider lobes (*P. amphixantha* up to 1 mm) and has fumarprotocetraric, succinprotocetraric and usnic acids (Pd— yellow turning crimson) whereas *P. amphixantha* has norstictic, stictic and usnic acids (Pd+ yellow) (Baker *et al.* 1973).

On soil, usually in deep shade. Specimens examined: *Barnard*, 12.xii.1927; *Eardley*, June, 1946.

**Parmelia subalbicans* Södt. 1877-78:254.

Thallus grey-blue, foliose, light brown below, lobes 1.5–4.0 mm broad, sparsely rhizinate, the margins irregular, branching sub-dichotomous. Apothecia common, the margin concolorous with the thallus, disc brown. Spores 8 per ascus, non-septate.

Very common on bark and dead twigs, usually with *P. ferax*. Specimens examined: *Anon.*, May 1942; *Womersley*, 6.vi.1946; *Rogers*, 20.ix.1967.

Physcia alba (Fée) Muell. 1887:12.

Parmelia alba Fée 1824:125.

Thallus grey-blue, foliose, forming distinct rosettes, closely adnate, lobes up to 3 mm broad, without soredia or isidia, pale below. Apothecia common, the margin concolorous with the thallus, disc brown, usually pruinose. Spores 8 per ascus, once septate, brown. Cortex K+ yellow, Pd+ yellow. Medulla K+ yellow, Pd+ yellow.

Rare on the bark of trees. Easily confused with *P. stellaris* in the field. Specimens examined: *Anon.*, May 1948.

Physcia albicans (Pers.) Thoms. 1963:88.

Parmelia albicans Pers. 1811:17.

Thallus blue to somewhat olive, foliose, forming distinct rosettes, closely adnate, lobes 1–4 mm broad, contiguous to the margin with ascendent labiate soredia; pale below, becoming dark. Apothecia rare, spores 8 per ascus, once septate.

brown. Cortex K+ yellow becoming red, Pd—; medulla K+ yellow becoming red, Pd—.

Rare, found on the bark of *Casuarina cristata*. Specimens examined: *Anon.*, May 1948; *Rogers*, 20.xi.1967.

Physcia stellaris (Ach.) Nyl. 1856:307.

Parmelia stellaris Ach. 1803:209.

Thallus blue-grey, foliose, forming rosettes or extended patches, not closely appressed, lobes 0.5–1.5 mm broad, without isidia or soredia, pale below. Apothecia common, the margin coloured like the thallus, the disc brown, often bluish pruinose. Spores 8 per ascus, once septate, brown. Cortex K+ yellow, Pd—; medulla K—, Pd—, yellow brown.

On the bark of trees, not common. Specimen examined: *Rogers*, 20.xi.1967.

Physciopsis syncolla (Tuck.) Poelt 1965:30.

Physcia syncolla Tuck. in Nyl. 1858:428.

Thallus brown, foliose, forming extensive patches, closely adnate. Lobes about 1 mm broad, dark below. Apothecia up to 1.5 mm broad, the margin concolorous with the thallus, the disc brown, sometimes pruinose. Spores 8 per ascus, once septate, brown.

Obscure, but in extensive patches on the bark of *Acacia mearnsii*. Specimen examined: *Rogers*, 20.xi.1967.

Synalissa symphorea (Ach.) Nyl. 1856:264.

Lichen symphoreus Ach. 1798:135.

Thallus dark olive-green to black, minutely fruticose, packed into patches up to 3 cm in diam., individual thalli 1 mm high, less than 1 mm in diam., branched, the lobes tightly packed, somewhat nodulate. Apothecia up to 0.2 mm in diam., more or less immersed in the tips of the upright lobes. Spores usually 8 per ascus, non-septate.

A very inconspicuous species on calcareous soil. Specimen examined: *Rogers*, 20.xi.1967.

Teloschistes chrysophthalmus (L.) Th. Fr. 1861:51.

Lichen chrysophthalmus L. 1771:311.

Thallus gold to grey, foliose, forming a shrubby clump, the lobes 0.5–2.5 mm broad with long marginal fibrils, with neither isidia nor soredia. Apothecia common, pedicellate, up to 6 mm in diam., with fibrils on the margin, concolorous with the thallus. Spores 8 per ascus, septate.

On twigs of bushes and bark of trees. Specimens examined: *Barnard*, 12.xii.1927; *Anon.*, May 1942.

Twinula caeruleanigriscans (Lightf.) Th. Fr. 1871:336.

Lichen caeruleanigriscans Lightf. 1777:805.

Thallus of dark grey, small (1 mm in diam.) inflated, reticulately cracked, usually blue-pruinose squamules. Apothecia often larger than the squamules, the margin and the disc both black, often pruinose. Spores 8 per ascus, fusiform, once septate.

Common on calcareous and sandy soils. Specimens examined: *Barnard*, 12.xii.1927; *Anon.*, May 1942; *Womersley*, 6.vi.1946; *Anon.*, May 1948; *Rogers*, 30.iv.1969.

Verrucaria aff. *calciseda* DC. in M. Lam. & DC.
1805:317.

Thallus a whitish crust, almost indistinguishable from the substrate, smooth, somewhat powdery. Perithecia immersed in pits in the thallus, showing as sunken black spots barely 0.1 mm in diam. Spores 8 per ascus, 24 μ m by 12 μ m, non-septate, hyaline.

An extremely obscure species on calcareous pebbles, appearing to be a pitted limestone surface unless carefully examined. Specimen examined: Anon., June 1946.

Xanthoria ectanea (Ach.) Räs. ex R. Filson 1969:
83.

Parmelia parietina var. *ectanea* Ach. 1810:464.

Thallus forming a golden rosette, foliose, adnate to the substrate, the lobes smooth, up to 2.5 mm broad, the margin raised then deflexed. Apothecia common, about 2 mm in diam. Spores 8 per ascus, septate.

Rare on twigs of *Lycium australe*. Specimens examined: Anon., May 1942; Rogers, 30.iv.1969.